GIS for Community Health Planning: A Guide for Software Developers

Thomas B Richards, MD (1),* Charles M Croner, PhD (2), Carol K Brown, MS (3), Littleton Fowler, DDS (4)

(1) Public Health Practice Program Office, Centers for Disease Control and Prevention, Atlanta, GA; (2) National Center for Health Statistics, Centers for Disease Control and Prevention, Hyattsville, MD; (3) National Association of County and City Health Officials, Washington, DC; (4) Association of State and Territorial Local Health Liaison Officials, Washington, DC; Cleveland County Health Department, Norman, OK

Abstract

Geographic information system (GIS) software products, data, and methods need to be developed to help local health departments and officials organize the process of community health assessment, identify preventable health problems, and improve public health programs and prevention effectiveness at the community level. We suggest that software developers explore the feasibility of forming private-public partnerships with innovative local health departments that have already started to apply GIS. In addition, we suggest focusing efforts on one (or a few) sentinel local public health issue(s), and developing modules that can be used separately, but that also can be nested together in a variety of different combinations, depending on a community's specific needs and priorities. The ultimate goal for local public health practice GIS product development is Web-enabled GIS with community-wide access, integrated with community planning tools such as *Assessment and Planning Excellence Through Community Partners for Health* and the *Guide to Community Preventive Services.*

Keywords: public health practice, community health planning, information systems, geography

Introduction

Geographic information system (GIS) technology can potentially offer important contributions to public health practice and management at local, state, and national levels (1–6). Software developers have started to ask, "What types of GIS software products and data methods would be useful in public health practice?"

The purpose of this paper is to help develop a dialogue on this topic by proposing types of GIS products that would be useful. In addition, this paper provides some general background about the public health marketplace for GIS products, models for organizing GIS within public health, and research challenges related to GIS software development.

* Thomas B Richards, MD, Centers for Disease Control and Prevention, 4770 Buford Highway, NE (K-55), Atlanta, GA 30341-3717 USA; (p) 770-488-3220; (f) 770-488-4639; E-mail: tbr1@cdc.gov

The Public Health Marketplace for GIS Products

Scant information exists about the current extent and types of GIS used by state and local public health agencies (7,8). Our general impression, however, is that GIS is still in its infancy in the context of public health management and practice. For example, a 1997 survey of state initiatives in geocoding vital statistics determined that only 21 of 49 responding state vital statistics registration bodies were involved in some type of automated geocoding of address data from vital records (8).

Public health practice typically involves multiple partners or collaborators. As a result, multiple public health marketplace niches, such as the following, exist:

- Federal agencies
- State health departments
- Large local health departments
- Small local health departments
- Health care organizations and providers

GIS specialty products likely will need to be developed for each of these. The focus in this paper, however, is on product development at the local level. From the perspective of community health planning, local health department (LHD) products are a logical starting point. Local level GIS offers the potential to incorporate information at the greatest level of detail and, if successful, might provide a building block for initiatives at other levels in the government hierarchy.

In addition to LHDs, a number of community health care organizations (e.g., hospitals and managed care organizations) may have considerable interest in population-based prevention programs at the local level. Thus, although the initial primary emphasis might be on developing GIS products for local health departments and officials, design features or products that have wider applicability (e.g., for use by groups such as hospitals and managed care organizations) would be beneficial.

Organizational Models for GIS in Local Public Health Practice

Four organizational models suggest how GIS might be incorporated into local public health practice:

- Model 1: Individual GIS user within a public health agency
- Model 2: GIS service unit for multiple GIS users within a public health agency
- Model 3: Enterprise-wide approach to GIS so that different programs within a public health agency can share GIS data
- Model 4: Web-enabled GIS with community-wide access

Model 1 is probably the most common at present. Models 3 and 4 are currently rare or do not exist within public health practice, but are likely to be perceived as a desirable goal by public health practitioners in the future.

Under Model 3, the LHD establishes priorities. Also, LHD spatial databases and automated systems are tailored to meet the established priorities, all while being shared among LHD programs (i.e., staff in one LHD program area are able to access spatial data in other LHD program areas in order to achieve the established priorities). Under Model 4, the LHD and its community partners join together to form a "community

enterprise" to improve public health performance, including a regional data warehouse. Shared data are on the Web, with different levels of access as needed to protect confidentiality of medical information. In addition, community groups are enabled to access and create their own maps after undergoing an educational program. Such a program would need to include discussion of potential problems in interpretation such as "lies with maps," the need to focus on comparisons where epidemiologists have already established etiologic relationships (9), and limitations in interpretation when rates are unstable because of small numbers.

GIS Research Challenges

At least eight research challenges will need to be met before the full power of GIS can be realized in community health planning:

1. Establish local public health agency enterprise-wide accessibility to local public health agency data (i.e., staff in one LHD program area are able to access spatial data in other LHD program areas in order to achieve the established priorities).
2. Establish local public health agency partnerships for integration and accessibility of georeferenced databases related to essential public health services, where the georeferenced data collected by the local public health agency can be used with georeferenced data collected by other government programs (e.g., planning, environment, or other municipal service departments) or other community health resources (e.g., hospitals, managed care organizations, and laboratories).
3. Build integrated linkage of GIS data, methods, and software with community planning tools (described below).
4. Develop local public health models for Web-enabled GIS systems with community-wide access—perhaps similar to the Community Health Mapping Engine (CHiME) Geographic Information Systems Project being developed by the Clackamas County Department of Health and Human Services, Oregon City, Oregon.[1] (see: *J Public Health Management Practice 1999*; 5(2):64–69).
5. Develop the capability to geocode, analyze, and make decisions using current georeferenced data (rather than data that are several years old).
6. Establish methods to preserve the privacy and confidentiality of medical information of individuals.
7. Document Federal Geographic Data Committee "metadata" (data about data) standards to facilitate exchange, interpretation, and analysis of public health GIS information (10).
8. Employ statistical and epidemiologic methods to GIS data related to disease surveillance and prevention decision-making by public health managers.

Community Planning Tools

GIS software, data, and methods need to be developed that build integrated linkages

[1] See Melnick A, Seigal N, Hildner J, Troxel T. 1999. Clackamas County Department of Human Services Community Health Mapping Engine (CHiME) Geographic Inormation Systems Project. *Journal of Public Health Management Practice* 5(2):64–69.

between GIS and community planning tools such as *Assessment and Planning Excellence Through Community Partners for Health* (*APEXCPH*) and the *Guide to Community Preventive Services* (11). *APEXCPH* is currently being developed by the National Association of County and City Health Officials, and builds upon the *Assessment Protocol for Excellence in Public Health* (*APEXPH*) (12). *APEXCPH* will emphasize the essential public health services (13), be available in electronic format, and explore the feasibility of incorporating GIS methods. The *Guide to Community Preventive Services* is currently being developed by a US Public Health Service Task Force and will provide evidence-based recommendations for preventive services and population-based interventions.

Building integrated linkage of GIS data, methods, and software to *APEXCPH* and the *Guide* (and to other community planning tools) provides a number of opportunities for GIS software development. The notion of linking GIS to *APEXPH* is not a new one. For example, in 1996, the Lewin Group proposed an *APEXPH*-related, GIS-based model (subsequently not fully evaluated) to aggregate data for community planning (14).

Although a single community planning tool might be the ultimate goal, given current funding constraints and the wide variety of topics in public health where research efforts might be focused, a reasonable research strategy for GIS software developers might be to focus initial efforts on developing a module for one (or a few) sentinel public health issue(s) where a small success can be demonstrated over a relatively short time period. Modules should be designed so that they can be used separately, but also so they can be nested together in a variety of different combinations, depending on the specific needs and priorities of a community.

Several examples of specific categorical program modules might include reducing the number of cases of vaccine-preventable diseases; preventing cardiovascular diseases; improving pregnancy outcomes and reducing infant mortality; preventing motor vehicle occupant injury and mortality; preventing childhood lead poisoning; and improving environmental health. Modules also could be developed for important (vertical) cross-cutting issues, such as training for beginning GIS users in LHDs.

We also suggest that GIS software developers explore the feasibility of forming private-public partnerships with innovative LHDs that have already started to apply GIS. The reasons for this are that software developers otherwise may experience considerable difficulty in obtaining access to databases to pilot test products, and insights from public health practitioners are needed to determine, for example, what constitutes a useful product and how results should be interpreted.

For those who want to learn more about GIS applications in the context of public health practice, a good source of information is the National Center for Health Statistics' free bimonthly e-mail report, *Public Health GIS News and Information.* To subscribe, send an e-mail to Dr. Charles Croner at cmc2@cdc.gov.

References

1. Croner CM, Sperling J, Broome FR. 1996. Geographic information systems (GIS): New perspectives in understanding human health and environmental relationships. *Statistics in Medicine* 15:1961–77.
2. Clarke KC, McLafferty SL, Tempalski BJ. 1996. On epidemiology and geographic information systems: A review and discussion of future directions. *Emerging Infectious Diseases* 2(2):85–92.

3. Vine MF, Degnan D, Hanchette C. 1997. Geographic information systems: Their use in environmental epidemiologic research. *Environmental Health Perspectives* 105(6):598–605.

4. Gordon A, Womersely J. 1997. The use of mapping in public health and planning health services. *Journal of Public Health Medicine* 19(2):139–47.

5. Office of Community Planning and Development. 1997. *Mapping your community: Using geographic information to strengthen community initiatives.* Washington, DC: US Department of Housing and Urban Development. HUD-1092-CPD.

6. Melnick A, Seigal N, Hildner J, Troxel T. 1999. Clackamas County Department of Human Services community health mapping engine (CHiME) geographic information system project. *Journal of Public Health Management and Practice* 5(2):51–7.

7. Warnecke L, Beattie J, Kollin C, Lyday W. 1998. *Geographic information technology in cities and counties: A nationwide assessment*. Washington, DC: American Forests.

8. MacDorman MF, Gay GA. 1999. State initiatives in geocoding vital statistics. *Journal of Public Health Management and Practice* 5(2):72–3.

9. Morgensten H. 1998. Ecologic studies. In: *Modern Epidemiology*. 2d ed. Ed. KJ Rothman, S Greenland. Philadelphia: Lippincott-Raven Publishers. 459–80.

10. Federal Geographic Data Committee. 1997. *Framework introduction and guide.* Washington, DC: Federal Geographic Data Committee.

11. Pappaionou M, Evans C. 1998. Development of the guide to community preventive services: A US public health service initiative. *Journal of Public Health Management Practice* 4(2): 48–54.

12. National Association of County and City Health Officials. 1991. *Assessment protocol for excellence in public health* (*APEXPH*). Washington, DC: National Association of County and City Health Officials.

13. Harrell JA, Baker EL. 1994. The essential services of public health. *Leadership in Public Health* 3(3):27–31.

14. Lewin Group, The. 1996. *Fulton County data aggregation system manual. Final report.* Contract #282-92-0041, Delivery Order #21. Fairfax, VA: The Lewin Group. October.